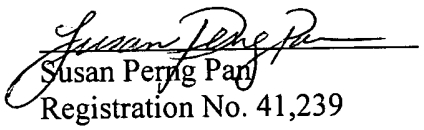
REMARKS

Entry and consideration of this supplemental Amendment is respectfully requested.

Respectfully submitted,



Susan Perng Pan
Registration No. 41,239

SUGHRUE MION, PLLC
2100 Pennsylvania Avenue, N.W.
Washington, D.C. 20037-3213
Telephone: (202) 293-7060
Facsimile: (202) 293-7860

Date: January 16, 2002

APPENDIX

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION:

The specification is changed as follows:

Page 1, first and second paragraphs, delete and insert the following:

BACKGROUND OF THE INVENTION

The present invention relates generally to a liquid crystal display device, and more specifically to a liquid crystal display device using a hologram diffuse plate. The present invention is also concerned with a hologram scatter plate used for liquid crystal display devices, etc., and a process of replicating [a] such a diffuse reflection type hologram.

Referring here to a direct-view type of liquid crystal display device, a scatter plate 12 is generally located on the side of a liquid crystal display element 20 opposite [to] a backlight 11 to diffuse light emanating therefrom, as shown in Figure 18, thereby widening a range capable of viewing an image displayed thereon (a visual field range).

Page 1, last paragraph, delete and insert the following:

A self-luminous type backlight consumes [very] a large amount of power, and [brings about some] causes considerable battery [driving] life [time] reduction when used with laptop [type] computers, etc.

Page 2, first, second and third paragraph, delete and insert the following:

SUMMARY OF THE INVENTION

In view of such problems associated with the prior art, an object of the present invention is to provide a liquid crystal display device which has a wide visual field range and [is] reduced [in terms of] luminance drops, so that bright displayed images can be presented.

Another object of the present invention is to provide a liquid crystal display device which uses a diffuse reflection type hologram for backlighting so that bright displays can be presented in the light without recourse to any self-luminous backlight. Yet another object of the present invention is to provide a liquid crystal display device which can be used in combination with a self-luminous type backlight, so that battery [driving time] life can be extended by [putting] turning off the self-luminous type backlight or using the self-luminous type backlight at a reduced luminance.

A further object of the present invention is to provide a hologram scatter plate enabling bright displayed images to be presented over a wide range of [wavelength region] wavelengths and viewing angle hardly achievable with conventional hologram systems.

Page 5, second and third paragraphs, delete and insert the following:

In accordance with this aspect, there are three cases where the transmission type hologram layer has [both] a diffusion function and a diffraction function while the back side layer is a mirror reflection layer; the transmission type hologram layer has diffraction function while the back side layer has a diffuse reflection function; and the transmission type hologram layer has both a diffusion function and diffraction function while the back side layer has diffuse reflection function.

The transmission type hologram layer used may have a diffraction function, or a diffusion function and diffraction function, with respect to a plurality of different wavelengths.

Page 7, second full paragraph, delete and insert the following:

According to the inventive hologram scatter plate wherein a transmission type hologram layer and a back side layer are stacked together in the described order, it is possible to limit the direction of diffraction and scattering by means of the transmission hologram and increase reflectance over a wide wavelength region by means of the back side layer, so that diffused light having high luminance can be obtained over a wide wavelength and viewing angle range, [so] making bright displays, etc. possible.

Page 9, second paragraph, delete and insert the following:

[Figure 5 illustrates] Figure 5(a) and Figure 5(b) illustrate an optical layout for recording a hologram scatter plate by a two-step exposure technique.

Page 9, sixth paragraph, delete and insert the following:

[Figure 11 illustrates] Figure 11(a) to Figure 11(c) illustrate schematically the construction and action of the hologram scatter plate according to the present invention.

Page 10, second paragraph, delete and insert the following:

[Figure 15 illustrates] Figure 15(a) to Figure 15(c) illustrate how to assemble a hologram plate support used in the layout shown in Figure 1.

Page 10, fourth paragraph, delete and insert the following:

[Figure 17 illustrates] Figure 17(a) and Figure 17(b) illustrate how to make a diffuse reflection type hologram plate by means of the two-step holography technique.

Page 10, paragraph 6, delete and insert the following:

[Figure 19 illustrates] Figure 19(a) and Figure 19(b) illustrate a conventional layout for making a diffuse reflection type hologram by a replication technique.

Page 10, last paragraph bridging pages 11 and 12, delete and insert the following:

Figure 1 is a sectional schematic showing one embodiment of the liquid crystal display device according to the present invention, which is similar to a conventional device shown in Figure [6] 18 in that a backlight 11, a scatter plate 12 and a liquid crystal display element 20 are located in the described order, as viewed from the side of the backlight 11. According to the present invention, a transmission type of hologram scatter plate 13 is located in front of a display surface of the liquid crystal display element 20. The hologram scatter plate 13, [because of having been] is fabricated by means of single-step or two-step exposure techniques [that] which will be described later[,] . The thus produced hologram scatter plate enables light more or less

scattered through the scatter plate 12 to be limitedly scattered within a given wide visual field range [, so that] . Accordingly, bright displayed images can be presented over a wide visual field range with little or no luminance reduction. The liquid crystal display element 20 used herein, for instance, comprises a twisted nematic or other liquid crystal layer 25 sandwiched between two glass substrates 21 and 22, one glass substrate 22 having a uniform opposite electrode 24 on its inner surface and the other glass substrate 21 having on its inner surface independent display electrodes 23 for each liquid crystal cell (R, G, B), and a color filter and a black matrix, although not illustrated. The electrodes 23 and 24 are also provided with orientation layers on their sides opposite to the liquid crystal layer, although again not illustrated. Further, the glass substrate 21 is provided with a polarizing plate 26 on its outer surface while the glass substrate 22 located on the viewing side is provided with a polarizing plate 27 on its outer surface, with their transmission axes perpendicular to one another, for instance. Voltage applied between the transparent display electrodes of the liquid crystal display element 20 is controlled per pixel to change the state of transmission, thereby displaying color images. It is noted here [to be noted] that the hologram scatter plate 13 may have been removed from the [layout] position shown in Figure 1 [or], and [alternatively, the hologram scatter plate 13 may be located] alternatively located between the backlight 11 and the liquid crystal element 20.

Page 12, first and second full paragraphs, delete and insert the following:

How to make the transmission type [of] hologram scatter 5 plate 13 used in the instant embodiment by means of holography will now be explained.

The visual field range of a liquid crystal display device is dependent on the angle of diffusion of the hologram scatter plate 13[, and the] . The smaller the angle of diffusion, the more difficult it is to look at a displayed image. To eliminate this problem, a hologram is recorded in a desired preset visual field range only where scattering and diffraction take place.

Page 13, last paragraph bridging page 14, delete and insert the following:

Figure 4 is a schematic illustrative of a holographic layout designed to determine a visual field in an oblique direction with respect to a hologram scatter plate [3] 13. One or more scatter plates 2, 2' are located at an off-axis position with respect to a hologram dry plate 1. The scatter plates 2 and 2' are then irradiated with laser light 3 and laser light 3' from their back sides, from which scattered light or object light is obliquely incident on the hologram dry plate 1 and reference light 4 is straightforward incident on the hologram dry plate 1. The object light and reference light are then allowed to interfere with each other in the hologram dry plate 1 for recording, thereby making the hologram scatter plate 13. In this case, too, the scatter plates 2 and 2' must be larger than the hologram dry plate 1, because the visual field region (range) of the hologram scatter plate 13 located at the position of the hologram dry plate 1 is defined by the regions of the scatter plates 2 and 2'. In the layout shown in Figure 4, exposure is done concurrently with the [concurrently located] scatter plates 2, 2'. It is to be understood, however, that recording may be carried out by means of multi-exposure while the scatter plates 2, 2' are located at the specified positions in a given time interval.

Page 18, first full paragraph, delete and insert the following:

A hologram photosensitive material (8E56 made by AGFA) was applied on a glass substrate to form a hologram dry plate. Using the optical system shown in Figure 5(a), the intermediate hologram Hi was [recorde] recorded under the following conditions:

Size of scatter plate 2: 6 cm x 8 cm

Size of hologram dry plate 1: 60 cm x 80 cm

Distance between scatter plate 2 and dry plate 2: 30 cm

Laser light 3, 4: 514.5 nm wavelength (argon laser)

Reference light 4: Incidence at 40°/parallel light

Object light: Vertical incidence/light scattered by scatter plate 2

Exposure: 150 $\mu J/cm^2$ (at an intensity of 1 mW/cm^2)

Intensity ratio between object light and reference light 4: approximately 1:1

Page 23, first full paragraph bridging page 24, delete and insert the following:

As shown in section in Figure 6, a diffuse reflection type hologram 31 obtained as mentioned above is located on the backlight side of a liquid crystal display device 20, thereby making it possible to construct a liquid crystal display device in which illumination light 32 incident from the display side of the liquid crystal display element 20 is diffused and reflected only within an angle range θ coincident with the viewing region of the liquid crystal display device to present bright displays even in the light without recourse to any self-luminous type backlight. The liquid crystal display element 20 used therein, for instance, comprises a twisted nematic or other liquid crystal layer 25 sandwiched between two glass substrates 21 and 22, one glass substrate 22 having a uniform opposite electrode 24 on its inner surface and the other glass

substrate 21 having on its inner surface independent display electrodes 23 for each liquid crystal cell (R, G, B), and a color filter and a black matrix, although not illustrated. The electrodes 23 and 24 are also provided with orientation layers on their sides opposite to the liquid crystal layer, although again not illustrated. Further, the glass substrate 21 is provided with a polarizing plate 26 on its outer surface while the glass substrate 22 located on the viewing side is provided with a polarizing plate 27 on its outer surface, with their transmission axes perpendicular to one another, for instance. Voltage applied between the transparent display electrodes of the liquid crystal display element 20 is controlled per pixel to change the state of transmission, thereby displaying color images. It is noted here [to noted] that by providing a diffuse reflection plate or reflector plate on the back side of the diffuse reflection type hologram 31 in the layout shown in Figure 6, it is possible to achieve great luminance improvements.

Page 24, first full paragraph, delete and insert the following:

By taking advantage of a reflection type hologram capable of diffracting a specific wavelength alone and transmitting light in other wavelength region, it is possible to set up an arrangement wherein a self-luminous type backlight 34 is located in combination with the back side of a diffuse reflection type hologram 31, as shown in Figure 7. According to this arrangement the self-luminous type backlight 34 can be used to illuminate the hologram 31 with light 35 therefrom when the liquid crystal display device is used in a dark place. When the liquid crystal display device is used in the light, the self-luminous type backlight 34 is used at a reduced luminance or [put] turned off, so that the hologram 31 can be illuminated with diffused

and reflected light 33 of extraneous light 32. It is thus possible to extend the battery driving time of a portable computer or the like, with which a liquid crystal display device is used.

Page 27, last paragraph bridging page 28, delete and insert the following:

The hologram scatter plate according to the present invention [is characterized by comprising] comprises a transmission type hologram layer and a back side layer, as viewed from an incident side thereof. This hologram scatter plate is broken down into three types depending on where [to have] the scatter function is performed. As shown schematically in Figure 11, a first type of the hologram scatter plate 53 comprising the transmission hologram layer 51 and the back side surface 52 allows only the transmission hologram layer 51 to have diffusion and diffraction functions and the back side surface 52 to be provided in the form of a mirror reflection layer (Figure 11(a)); a second type allows the transmission hologram layer 51 to have diffraction function alone and the back side layer 52 to have a diffuse reflection function (Figure 11(b)); and a third type allows the transmission type hologram 51 to have diffusion and diffraction functions and the back side layer 52 to have diffuse reflection function (Figure 11(c)). Note that reference numeral 62 represents illumination light.

Page 37, last paragraph bridging page 38, delete and insert the following:

Figure 14 illustrates one exemplary layout for carrying out the replication process according to the present invention, and Figure 15 shows how to assemble a hologram plate support used in carrying out the same. In the present invention, a plate form of diffuse reflection hologram 61 to be replicated is applied, in striped forms, on the surface of a semicylindrical

transparent member 62 in its generating line direction. A photosensitive material film 63 is brought into close contact with the hologram plate 61 while a droplet form of index matching liquid or lubricant 65 is fed between them through a dropping feeder 64. While the photosensitive material film 63 is slid in the circumferential direction of the transparent member 62 that crosses the striped form of hologram plate 61, it is fed in a direction shown by an arrow of Fig. 14. In this feeding process, at a position where the photosensitive material film 63 is in close contact with the hologram plate 61, laser light 66 is permitted to be incident on the hologram plate 61 from the photosensitive material film 63 such that it crosses the photosensitive material film 63 and provides a full coverage to the longitudinal direction of the hologram plate 61. The incident light, and light reflected and diffracted from the hologram plate 61 are thus made to interfere successively with each other in the photosensitive material film 63, so that a large diffuse reflection type hologram that is continuously extended in the moving direction of the photosensitive material film 63 can be fabricated by replication.

Page 40, last paragraph bridging page 41, delete and insert the following:

Then, this first hologram, shown at 77 in Figure [17(c)] 17(b), is located at the position of the former transmission type of hologram dry plate 75, and a reflection type of hologram dry plate 80 is now located at the position of the scatter plate 70. The hologram 77 is irradiated with reconstructing illumination light 78 that is opposite in the direction of propagation to, and the same in wavelength as, the recording reference light 76 such that a real image of the hologram 77 can be formed at a position of the reflection type of hologram dry plate 80 (corresponding to the position of the scatter plate 70 shown in Figure 17(a)), whereupon diffracted light 79 from the

hologram 77 or object light is incident on the reflection type of hologram dry plate 80. At the same time, reference light 81 that propagates opposite to incident light assumed for the diffuse reflection type hologram 61 is incident on the opposite side of the reflection type of hologram dry plate 80, whereby a second or diffuse reflection type of hologram plate is recorded on the reflection type of hologram dry plate 80. In this way, it is possible to fabricate the diffuse reflection type hologram plate 61 with a viewing region limited to the range of the first hologram 77.